Remarks

The pending claims are 16 and 18-29.

Claim 28 has been amended to make the range of oxygen concentrations consistent with the claim to which it depends. This amendment obviates the rejection made under 35 USC 112, second paragraph with respect to claim 28.

Summary of Invention

Appellants' invention is directed to a fluidized bed, gas-phase, process for manufacture of vinyl acetate from ethylene, acetic acid, and oxygen. In Appellants' process, separate feed streams primarily containing hydrocarbons and oxygen are introduced into a fluidized bed reactor, such that neither feedstream nor the outlet gas from the reactor is within flammability limits. Because oxygen is consumed in the reactor through catalytic oxidation of ethylene and acetic acid to form vinyl acetate, the oxygen concentration in the reactor will be lower than the sum of components of the input feedstreams. Also, because the oxygen concentrations in the feedstreams are constrained by safety concerns of creating an explosive mixture, separation of the feedstreams results in an effective higher usage of oxygen in the reactor. This increases the oxidation efficiency of the catalytic oxidation reaction.

Separation of the primary oxygen feedstream from the primary hydrocarbon feedstream is possible in Appellants' fluidized system because the fluidization medium in the reactor will prevent uncontrolled oxidation at the point of entry of the oxygen feedstream into the reactor. In contrast, a separate introduction of high concentration oxygen into a fixed bed catalytic reactor system would not be possible because of the probable creation of a "hotspot" at the point of entry.

Significantly, the invention claimed in independent claim 16 requires that the total amount of oxygen employed is higher than may be used without danger of flammability, if all streams were combined. In independent claim 27, the levels of oxygen employed are higher than may be used in a fixed bed reactor, without danger of flammability.

Appellants' invention results in a more efficient oxidation reaction within acceptable safety restrictions.

Rejections Under 35 USC 103(a)

Claims 16-28 were rejected under 35 USC §103(a) over Sennewald et al. (GB 1,266,623) and Sennewald et al. (GB 1,266,624) in view of Provine (US 5,688,993) optionally in view of Calcagno (US 3,714,237).

The Examiner stated that the GB'623 and GB'624 references teach the claimed process except oxygen is not introduced in a further inlet. The Examiner further asserted that whether oxygen is added with the other reactants or separately "appears to be merely an arbitrary choice." The basis for this assertion is that "it would be readily apparent to one of ordinary skill in the art the ultimately desired results of all reactants being present in the reactor would be achieved regardless of whether oxygen is fed separately from or together with the ethylene and acetic acid."

The rejection continues to assert that it was recognized in the process of US'237 that oxygen can be supplied from other feeds. Although US'237 was characterized as being "very similar" to the claimed process, there was recognition that it is not the same process.

Applicants' Analysis of the Rejections and Their Argument For Patentability

Applicants do not contend that their claimed process involves new chemical reactions. The reaction of ethylene, acetic acid, and oxygen to form vinyl acetate is well known.

However, Applicants do contend that the amounts of the reaction components added to a reactor system in their process have not been disclosed or suggested by the cited references.

In order to understand Applicants position, the actual disclosure in each of the cited references must be analyzed.

Sennewald et al. (GB'623 and GB'624) describe a fluid bed (i.e., gas phase) system in which ethylene, acetic acid, and oxygen are reacted in the presence of a catalyst to form vinyl acetate. Without question neither Sennewald et al. documents disclose separate addition of oxygen-containing input streams into a gas-phase reactor. There is no current issue that the two Sennewald et al. references alone either disclose or suggest Applicants' claimed invention.

With respect to the amount of oxygen described in Sennewald et al., a prior Office Action pointed to Example 2 of Sennewald et al. which described a catalytic gas-phase reaction under a pressure of 8 atmospheres absolute of:

65 vol.% ethylene,
16 vol.% acetic acid,
8 vol.% oxygen, and
11 vol.% carbon dioxide.

Note that the ethylene/oxygen volume ratio in this mixture is 65/8 = 8.1.

In order to support a rejection under 35 USC 103(a), the latest Office Action cited Calcagno (US'237) as a "very similar process." In fact, Calcagno describes a significantly different process than presented in either the Sennewald et al. documents or Applicants' invention. In Calcagno, gaseous ethylene and oxygen are fed into liquid acetic acid containing catalytic salts. The reaction products leaving the reactor, which include vinyl acetate, pass through an adsorption column from which gas products are recycled to the reactor and the liquid product (containing vinyl acetate) is stripped of gases and distilled to produce vinyl acetate.

[Applicants note that the description contained in the Calcagno et al. document is difficult to understand, apparently due to translation into English. For example, the reference to an "oxidation column" at col. 3, line 12, may actually refer to an "absorption column" as described further.]

Apparently, because of the need to keep the reaction in the liquid state, the pressure required by Calcagno et al. is relatively high (exemplified as 30 atmospheres, ~420 psig) and exceeds the recommended pressure used by either Sennewald et al. or in Applicants' invention.

Applicants first contend that reaction conditions described in Sennewald et al. and Calcagno et al. are significantly different and cannot be said to be "very similar."

In any regard, the Office Action noted col. 2, lines 4-9, of Calcagno et al. as a basis of finding similarity between Sennewald et al. and Calcagno et al. This passage refers to adding gaseous ethylene and oxygen through an acetic acid solution, and states:

> "More particularly, according to the method here proposed, ethylene and oxygen, fed separately and/or mixed together so the volumetric ratio of ethylene to oxygen lies between 9:1 and 21:1 and preferably between 14:1 and 18:1, are passed through a catalytic mixture dissolved and/or in suspension, in a suitable reaction vessel.:

In order to understand the teaching of this passage, it must be noted that Calcagno et al. only feed gaseous ethylene and oxygen into liquid acetic acid. Thus, the amount of ethylene and oxygen are described as volume ratios. In a two-

component system the range of ethylene/oxygen ratios of 9:1 to 21:1 converts to 4.5 to 10 volume percent of oxygen in the gas. However, in a system which must contain other gaseous components, these ethylene/oxygen volume ratios convert to significantly different amounts of oxygen expressed as volume percent of the total gaseous mixture. It is clear from the disclosure of Sennewald et al., that at least gaseous acetic acid and typically inert gases such as carbon dioxide are present. For example, the previously-identified gaseous components in Sennewald et al. example 2 (containing 8 vol.% oxygen) has an ethylene/oxygen volume ratio of 8.1, which is outside even the broad range disclosed by Calcagno et al.

Applicants conclude that Calcagno et al. does not teach the amount of oxygen present in a gas-phase reaction system, which must contain at least gaseous acetic acid in addition to ethylene and oxygen.

Further, even if Calcagno et al. can be used to show a separate addition of oxygen into a liquid-phase system, the actual results (col. 3, lines 38-41) shown by Calcagno et al. were a very low conversion rate (3%) and typically low ethylene selectivity (~85%) compared to Applicants' typical conversion rates above 10% and generally higher VAM selectivities (for examples 9-19). Applicants thus submit there was no motivation to combine the purported teaching of Calcagno et al. with Sennewald et al. without a suggestion of better results.

Thus, there is no basis for the assertion in the latest Office Action that:

> "No unexpected result is seen for supplying the oxygen separately at the same concentration as suggested in the prior art and applicants do not present any persuasive evidence that their process would afford any expected result when operating at the prior art feed rates."

Contrary to the assertion made in the Office Action, Applicants contend that the art does not teach operating at the combined oxygen concentrations claimed in a gas-phase reaction system.

As the basis for the statement in the Office Action that Applicants are operating in the "prior art feed rates" that exceed the flammable limits of the feed mixture, the Examiner specifically cites US'993. The Office Action states:

> The claims required that the amount of oxygen used to exceed the flammable limits of the feed mixture and read on the amount exemplified in US'993 note col. 6 lines 51-52 recites that oxygen is present in the range of 1-20%, preferably 5-10% which is apparently within the claimed range.

A review of the passage cited in the Office Action shows, in fact, that the ranges cited by the Examiner were not "exemplified" in the sense of reciting actual examples using concentrations of oxygen, ethylene, and acetic acid throughout the broad ranges stated at col. 6, lines 48-52 of US'993. In fact, there is direct evidence in US'993 that the concentrations claimed by Applicants are to be avoided. Attention is drawn to col. 1, lines 54-57, which poses the design constraints for these types of processes:

"Another common design constraint relates to reagent concentrations, particularly oxygen concentration, due to explosion or fire concerns."

The invention disclosed in US'993 is directed to increasing the effective amount of catalyst. As stated at column 2, lines 5-11:

> The present invention is quite innovative, because a greater amount of catalyst can generally be used, relative to the above described conventional process; as a result, the process of the present invention generally need not be shut down as often for catalyst replacement. The additional amount of catalyst does not create a safety hazard (or other concerns) however;" (emphasis added)

Also, at col. 7, lines 26-29, US'293 teaches the person of ordinary skill in the art the range of explosion limits clearly for the purpose of a safety warning:

> "It should be noted that the explosion limit under these process conditions generally lies in the range of about 5-15% of oxygen."

Thus, the cited US'993 reference clearly recognizes the problem of excessive oxygen concentrations with regard to safety. The solution posed in US'993 is to increase the effective amount of catalyst (which would be the expensive component in the reaction mixture) and not oxygen. The recitation of broad ranges in col. 6 of US'993 must be read in conjunction with the totality of the disclosure. In doing so, it is apparent that US'993 does not teach using oxygen concentrations in an actual system, which exceed flammability limits. Any contrary teaching in US'993 would be non-enabled and cannot be a basis for rejection of Applicants' claims.

Applicants point out that the oxygen concentration limits contained in Applicants' claims recite both a numerical limit ("at least 9 volume percent") and a functional limit

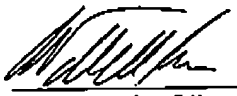
("total amount of oxygen employed is higher than may be used without danger of flammability, if all feed streams were combined"). Specifically, US'993 does not teach operating with a total amount of oxygen employed is higher than may be used without danger of flammability, if all feed streams were combined, irrespective of broad numerical composition ranges appearing its description.

Based on the above, Applicants submit that the proposed combination of references does not make a prima facie case for obviousness under 35 USC 103(a). In any regard, Applicants have shown that their process operates more efficiently than the processes described in any of the cited documents.

Summary

Applicants' currently-presented claims require features not described in the cited art. Significantly, all of the pending claims now require operation of a process using oxygen feeds higher than the art would have considered acceptable in regard to safety. This operation directly leads to higher activity and throughput and more efficient operation. Thus, Applicants submit that all pending claims are in condition for allowance and request the Examiner to reconsider the rejections.

Respectfully submitted,



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